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Adopting an ecosystem approach for improved stewardship of the maritime environment: some overarching issues

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Adopting an ecosystem approach for improved stewardship of the maritime environment: some overarching issues

Prepared for the Review of Marine Nature Conservation and the
Marine Stewardship process by English Nature,
the Countryside Council for Wales, Environment Heritage Services (Northern Ireland),
the Joint Nature Conservation Committee and
the Royal Holloway Institute for Environmental Research.

RMNC consultation draft

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Context

This paper is a further contribution towards the development and implementation of the ecosystem approach to the management of the UK and European maritime environments. It complements other reports tabled to the Review of Marine Nature Conservation (RMNC) by JNCC, the country agencies and others (see annex 1 for a full list).

This paper is intended to stimulate a debate on a range of wider practical marine environmental considerations that should overarch the Defra-led Irish Sea Trial. The paper is not yet complete and forms a consultation version for the RMNC. We intend to produce a revised complete version for tabling at the November RMNC meeting.

It is our intention in that revised version to expand the framework in Table 2 to cover monitoring issues at the various spatial scales described, to complement the science and governance issues outlined. We also intend to build in elements to better address awareness raising and the building up of skills and capacity, in so far as it is possible to address such matters in the table. Subsequent to that version, as ideas and initiatives develop we may revise and add to this report.

In compiling this report the authors are grateful to a wide range of organisations that offered comments on previous versions including CEFAS, Marine Biological Association, WWF, RSPB, The Environment Agency, MCS, SNH, Proudman Oceanic Laboratory, Professor Bryan Jenkins, Director of the Murdoch Environment Centre, University of Murdoch, Western Australia. The views expressed however in this report represent those of the authors and not the organisations listed above.

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Contents

1. Introduction

1.1 In September 2002, the statutory nature conservation agencies, Environment Heritage Services (Northern Ireland) and JNCC tabled a paper for the Review of Marine Nature Conservation Working Group called *An implementation framework for the conservation, protection and management of nationally important marine wildlife in the UK* (Laffoley *et al* 2000). This proposes and sets out the rationale for a strategic framework to develop new approaches to marine conservation in the UK. Defra Ministers decided that elements of the framework should be investigated through a multi-stakeholder trial focussed on the Irish Sea; this is underway and will report in 2004.

1.2 This current paper intends to complement the Irish Sea Trial by developing ideas on the overarching framework needed for improved stewardship of the maritime environment[1]. This paper takes the original framework proposed by Laffoley *et al* (2000) and complements it with broader contextual issues. These are:

- clarifying the terminology that should be used;
- proposing the adoption of Large Marine Ecosystems or equivalent as the basis for implementation of an ecosystem approach in maritime environments, rather than the administratively-based designated sea area of a country;
- highlight practical steps in governance and science that need to be addressed at various spatial scales in order to improve the current approach to stewardship of maritime ecosystems and delivery of an ecosystem approach;
- recognising that it is improving the capacity and ability to handle risk and uncertainty that should be a driving force in evolving institutional arrangements for the management of maritime ecosystems;
- initiating a debate on reporting against the ecosystem approach and the shape and form future Public Service agreements and their associated indicators may accordingly need to take.

2. Delivering an ecosystem approach: definition and terminology

2.1 Much has been written over the past few years about the need to deliver 'sustainability', and develop an organisational methodology for the integrated management of natural resources which complements but essentially goes beyond 'classical' conservation concepts such as endangered species or habitat protection and various types of protected area designations. Ecological concepts now permeate completely the thinking of those organisations challenged with the sustainability of natural resources. The ecosystem model has formalised the recognition of functional links among species, such as trophic hierarchy or food webs, and between organisms and their environment (such as in the flow and exchange of nutrients, sediments and water).

[1] 'Maritime environment' is used throughout this report to reflect the relationship and interdependence of coastal, estuarine and marine environments as part of an ecosystem approach

2.2 Human actions can influence either directly (such as biomanipulations and differential harvesting, fertilisation or acid amelioration of water bodies) or indirectly (such as through land use, diffuse pollution or altered river flows) the structure and functioning of ecosystems. This in turn influences their ability to sustain the natural resources essential for use by humans as well as other species.

2.3 A distinction has been made between ecosystem management, defined as the direct manipulation of the species and/or the physical, chemical and biological processes which link organisms with their abiotic environment, and ecosystem-based management, in which the emphasis is not on ecosystem process *per se* but on 'human actions which are likely to alter those processes in magnitude or pattern' (Maltby, 1997). Application of ecosystem-based management is only partly about science. 'It is about coupling sustainable economic, social and political systems with a sustainable environment maintaining the biodiversity and natural resources on which we all depend' (Maltby, 1999). This more holistic approach to sustainability and biodiversity conservation has been captured in a wide range of terminology, broadly synonymous but with often subtle or obscure variation in interpretation (McNeely, 1999). Thus 'bioregional planning', 'the ecosystem approach', and 'ecosystem-based approach', 'biosphere reserves', and 'integrated coastal zone management' are terms that have been used interchangeably.

2.4 The 'ecosystem approach' is however the terminology adopted by the Conference of Parties of the Convention on Biological Diversity (CBD) as the primary framework for delivery of the three key objectives of the Convention: conservation of biodiversity, sustainable use and equitable sharing of the benefits arising out of the utilisation of genetic resources. In this report we use 'the ecosystem approach' as defined by the CBD[2] in preference to the alternative terminologies for several practical reasons:

- its formal adoption by the global Convention on Biological Diversity and specific obligations on the part of contracting parties including the UK (see decision COP V/6);
- linkages to other international conventions including Ramsar and CSD;
- references to precise commitments under the plan of implementation of the World Summit on Sustainable Development including the marine environment;
- it offers a definition underpinned by clearly specified principles and operational guidance for implementation;
- a growing body of technical experience is orientated towards its practical application (eg Smith and Maltby 2003, Korn *et al*, 2002).

[2] The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. It recognises that humans, with their cultural diversity and varied societal needs, are an integral part of ecosystems.

3. The ecosystem approach and its relationship to Large Marine Ecosystems (or equivalent)

3.1 Laffoley *et al* (2000) set out a basic hierarchical framework for delivery of an ecosystem approach to the maritime environment. The major development since that report is the proposal made here to adopt Large Marine Ecosystems or equivalent (such as OSPAR regions) as the fundamental environmental basis for delivery of the ecosystem approach in maritime environments. This is as opposed to the wider sea being treated on a purely administrative basis (i.e. the UK designated area). The adoption of Large Marine Ecosystems or equivalent is seen as an essential step, both in the UK and Europe, towards a more ecosystem orientated approach. By default, processes have been moving in this direction (i.e. the increasing focus on the Baltic, the Black Sea and so on) but now need to be embraced in full and in a fully integrated manner by the regime of overlapping initiatives that characterises the current approach to marine management and stewardship.

3.2 LMEs (see Figure 1) are maritime areas that display distinct topography, hydrography and productivity and trophically linked populations. LMEs in UK waters are shown in Figure 1. Thus the four overlapping spatial scales now consist of:

- large Marine Ecosystems (LME) or equivalent;
- regional seas and coasts;
- marine, coastal and estuarine landscapes; and
- habitats and species.
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- The role of each of these levels is summarised in Table 1.

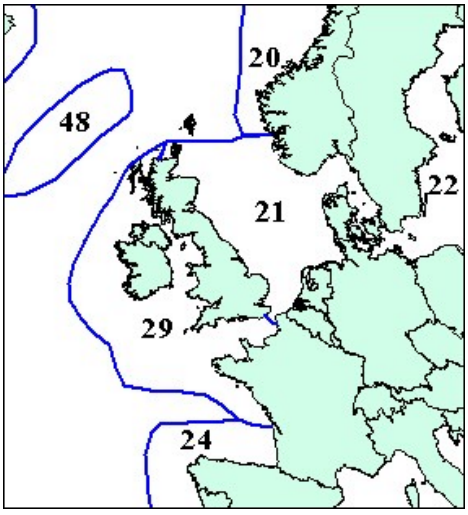

Figure 1 Large Marine Ecosystems around the UK (from Sherman *et al* 1996)

4. Practical steps in governance and science needed to improve the current approach to stewardship of maritime ecosystems and delivery of an ecosystem approach

4.1 Table 2 identifies major steps in governance and science needed to migrate current management practices for the stewardship of seas and coasts into one fully centred on ecosystems using such a nested approach. The table summarises a national strategic-level analysis of management framework goals for each level, an assessment of where current management appears to be and therefore what gaps need to be addressed, and an outline of what this means for governance and science.

4.2 The framework in Table 2 is not intended as a blueprint for future action but rather as an indicator of what we consider needs to be addressed. The relationship between the framework contained in Table 2 and the principles of the ecosystem approach is given in annex 2 with the original principles listed in annex 3. The table demonstrates that it is better management of activities and integration of regulatory mechanisms that is at the heart of achieving improved ecosystem health. These issues need to be addressed at scales appropriate to the ways in which ecosystems are structured and function and the goods and services they provide.

4.3 The framework builds on ideas in the Marine Stewardship report and may be a useful contribution towards Defra's Horizon Scanning Programme. We hope that Table 2 will challenge existing bodies, such as IACMST, to expand their remit to address some of the areas suggested, rather than by the creation of yet further bodies and organisations. The unacceptable lack of coordination in maritime science and research is a case in point that the table highlights alongside other considerations.

4.4 Table 2 demonstrates a relationship between the different levels. Successful implementation at each level is dependent on the other levels (hierarchical interdependence). There is also a natural progression in the governance framework, from habitats and species to wider seas and coasts, and from protection through management to planning.

4.5 Table 2 established the roles of marine protected areas as just a small but significant part of the full suite of measures required to improve the condition of marine ecosystems and the overall quality of stewardship. It identifies two types of marine protected areas - multiple-use marine and coastal protected areas (MCPAs), such as Special Areas of Conservation (under the Habitats Directive - which are protected but the emphasis is on activities continuing unless damage can be demonstrated), and the role of Highly Protected Areas – where exclusion of activities and greater levels of precaution are the norm. Multiple-use MCPAs are a management tool with limited protective measures, to conserve ecological processes and functionality at the 'landscape' level (e.g. estuaries, bays, sediment systems). By contrast, Highly Protected Areas are a wholly protective tool to maintain and allow recovery of ecosystem structure (e.g. physical structure of habitats, fish spawning/breeding habitats etc). This twin-track approach is an important principle at the heart of better Stewardship. The main relationships between the four levels are illustrated in Table 1.

5. Relationship between the framework and improving Government's capability to handle risk and uncertainty

5.1 The recognition of the need to improve the capability to manage risk and uncertainty forms an important element of the Government's reform strategy and is central to the business of good government (Cabinet Office, 2002). The current approach to the management of the maritime environment exposes Government to considerable risk. Addressing and managing such risk effectively requires new thinking as well as encouraging current initiatives to improve the situation. Without new mechanisms valued social, economic and ecological interests will continue to be compromised and damaged. For example:

- Stocks of commercially exploited marine fish species are at an all time low and science is demonstrating ecosystem effects beyond the commercial species themselves, manifested in a declining ecosystem state. Policy and operational decisions are at odds with scientific advice over the levels of ongoing exploitation. Pre-agreed risk management strategies are not being employed as part of such decisions to prevent further decline in stocks year on year. Decisions are not recognising the degree of wider and area-based conservation measures needed to guard against the ecological effects of continued fishing pressure to provide for sustainable solutions in the future. This puts at increased risk the 20,000 or so individuals and their communities who are dependent on at least maintaining the current (poor) state of stocks in order to make a living (social and economic), as well as the ecology of our seas. A significant step forward in this respect may be the Prime Minister's Strategy Unit project on marine fish, which seeks better solutions to the risks inherent with fisheries management in order to deliver a medium to long-term solution for a return to a sustainable situation. A key part of this will need to involve far greater integration of fishery stakeholders, and the ecological knowledge they posses, into any future process.

- The lack of progress on maritime conservation measures over the past decade, set against the continued and increasing exploitation of maritime resources and development of international obligations and agreements for the sea, is increasing uncertainty and risk for industry. Offshore industries such as oil and gas, aggregates and wind farms require a clearer picture of which parts of marine ecosystems are important and for what reasons, with this information presented in a meaningful spatial context. Current policies of pushing forward with industrial development, whilst making slower progress on area-based and wider maritime conservation measures, in the absence of a spatial context, is increasing the actual and potential risk to delivering sustainable management of maritime resources.

5.2 The proposed framework in this paper encourages better management of risk and uncertainty by:

- Promoting the definition and practical application of the ecosystem approach within critical marine sectors such as fishing, oil and gas and tourism
- Providing a framework for the practical development and implementation of an ecosystem approach,
- Highlighting the role different governance tools at different spatial scales have to address the risks human activities pose to ecosystem health
- promoting an examination of how governance of maritime resources could be better integrated,
- promoting enhanced use of science to underpin evidence-based and risk-averse policy, and management practice,
- promoting management measures that are coincident with the scales of ecological processes determining the effects of human activities upon maritime systems,
- defining the role and contribution that area-based recovery measures can make across the hierarchy of spatial scales.
- Initiating debate on the development of Public Service Agreement targets to provide a practical Department-led underpinning of the Government's strategic goal for the seas.

6. Reporting on an ecosystem approach

6.1 Adopting an ecosystem approach to maritime stewardship requires a reappraisal of existing marine monitoring and reporting procedures (see Laffoley *et al* 2002 for an initial discussion). This in turn impacts on consideration of how the elements of marine biodiversity may be best used as indicators for overall sustainable development and, more specifically, the England Biodiversity Strategy (Defra, 2002), and how these then may be translated into Public Service Agreement targets for Government.

6.2 An ecosystem approach will require the use of additional information above and beyond that collected by monitoring of regulatory responsibilities. Regulatory responsibilities often only relate to impacts on elements of ecosystems, and because current monitoring has a focus on the use of indicators that relate to manageable activities. In the marine environment synergistic effects are an increasing concern and Table 3 illustrates the scale and range of ecosystem components that may need to be considered to assess progress under an ecosystem approach. Ultimately though any improvements to the maritime environment must be implemented through individual manageable activities, although broader-scale indicators than hitherto have been considered, will be required to signal the overall direction being taken by maritime ecosystems. ICES have recommended that at this early stage of indicator development, the best indicators are those that are closely linked to human activities.

6.3 There is currently a considerable amount of effort going into this area of work, both in the UK and Europe within sectors and/or individual organisations (European Environment Agency), which will require better coordination to deliver a minimum integrated suite of indicators to assess ecosystem health (and therefore presents best value for money). For example, In Bergen, Ministers agreed to make use of ecological quality objectives (EcoQOs) as a tool for setting clear operational environmental objectives directed towards specific management, and serving as

indicators of ecosystem health. Of the ten issues identified (commercial fish species, threatened and declining species, sea mammals, seabirds, fish communities, benthic communities, plankton communities, habitats, nutrient budgets & production and oxygen consumption), commercial fish species, sea mammals and seabirds are most advanced in their development. Similar work on indicators is underway by Defra, through the Strategy for the Conservation and Sustainable Development of the Marine Environment and through the England Biodiversity Strategy, under the water Framework Directive and by the European Environment Agency.

6.4 With regards to the ecosystem approach proposed in Table 3, information is known and published about many of the elements, but does not currently form part of a central view from Government on the state of our seas. It is accordingly particularly important to develop a framework for assessing the minimum suite of indicators that are needed to provide a meaningful assessment of the health of maritime ecosystems and the sustainability of human activities. Without this, lists of potential indicators cannot be considered as integrated and may not contribute to an ecosystem approach. The challenge for government is therefore to integrate, align and use all relevant knowledge to best overall effect to identify the minimum suite of indicators required. Table 3 provides an illustration of how a focus on ecosystem structure may help in this process, although it only relates to ecological aspects of ecosystem indicators. Social and economic indicators will need to be built into this assessment and reporting process.

7. Development of maritime environment Public Service Agreement (PSA) targets

7.1 One of the ultimate challenges arising from the development of an ecosystem approach is the creation of outcome orientated, high-level objectives and indices to enable the approach to be built into the operational activities of government in a manner that drives the delivery of results. Thinking therefore should be directed towards establishing and embracing the maritime environment equivalent of the 'farmland birds index' as future PSA targets.

7.2 Below are two suggested maritime PSA targets covering ecosystem heath and quality to initiate a debate on this topic. The ecosystem health index may be easier to apply than the one outlined below for ecosystem quality, although the latter is analogous to the approach that is already part of a PSA target for protected sites on land. If such ideas outlined below were to be taken forward, an implementation plan for each index would need to be prepared in an analogous way to that in existence and underpinning the farmland bird index.

- Possible PSA for maintaining wider ecosystem health using the ***'Marine fish index'.*** *This index would use the average annual trophic level of fish caught.* In plain English the indicator represents the average position in the food chain of caught fish, the theory suggesting (and published evidence now documenting) that fish species that feed higher up in the food chain are being lost as a result of over fishing and that this is changing ecosystem composition and risking de-stabilisation of overall ecosystem structure. This could use the methodology derived from CEFAS and from the USA and British Columbia. The target can

provide a quantifiable data across several fisheries (thus providing a single figure that lends to graphical interpretation and trend analysis over time), it can be related to fishing areas, it can be used to isolate differential effects on benthic and pelagic stocks, and overall, reflects broader ecosystem health. PSA target should be to halt the decline currently being recorded, stabilise and then recover. Initial targets for recovery could be established for the North Sea and Celtic Sea on the basis of published data and by embracing the ecological knowledge contained within the industry. The target therefore could be refined by addition of information on total annual catch data, and improved by addressing illegal and unreported landings. If the total sum of all management actions and precautionary effort directed at recovering stocks is successful, the average trophic level of landed fish should stabilise and then show recovery. Targets from Gothenburg and WSSD can be incorporated as illustrated in Figure 2 showing the overall level of ambition that faces the Government's marine stewardship in delivering sustainable use.

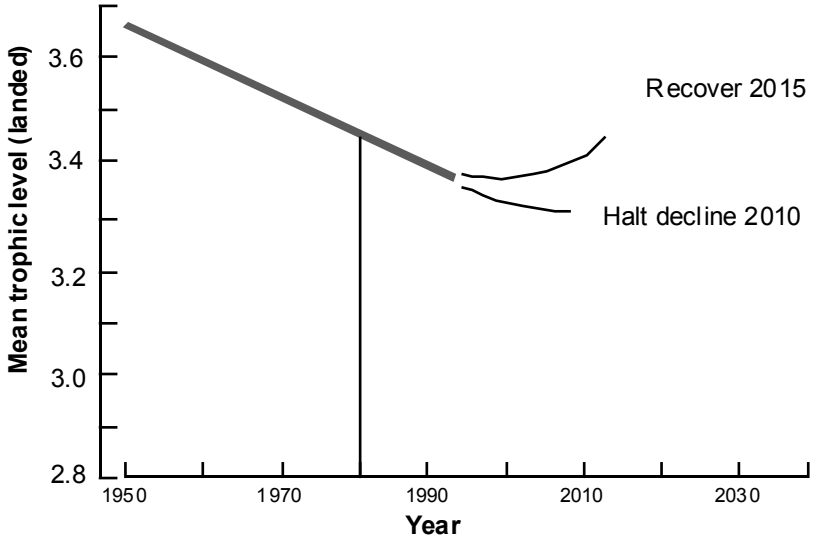

Figure 2 Trophic trend in caught fish (landed) for the northeast Atlantic since the 1950s (derived from Pauly *et al* 1998), linked to targets for future action to halt the decline in biodiversity by 2010 and recover fish stocks where possible by 2015. 1980 has been taken as a reference point against which to gauge recovery.

- Possible PSA for maintaining marine ecosystem quality using the **'Marine quality index'.** The indicator for this objective would be a composite index consisting of: documenting the proportion of marine waters by area considered to have good ecological status, **and** documenting the total area of seabed allocated to long-term biodiversity recovery, or percent of designated marine sites that are unfavourable and recovering, through to favourable condition. There are strong links to the existing PSA target for SSSIs, the Water Framework Directive, MCPA initiatives and European and domestic reporting requirements.

8. References (to be completed)

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Table 1. Summary of nested ecosystem elements and overall purpose (developed from Laffoley *et al*, 2000)

'Nested' ecosystem elements & comparative scale	**Principle focus**
Large Marine Ecosystems ca. 200,000 km^2 or larger	• Cooperative working by nations bordering LMEs • The conservation, protection & management of wide-ranging marine species & commercial stocks; • The maintenance of ecosystem health, including sustainability indicators, concept of good ecological status, & links between marine wildlife & principle issues, eg fishing, water quality etc.; • Better integration, planning and management of sea uses; • understanding of marine environmental change & functional processes – cause, effect & implications on the coast.
Regional seas & coasts ca 6000 – ca 70,000 km^2	• Gathering/disseminating marine conservation information & knowledge at the regional scale; • Using a regional framework for assessing the marine resources, integration with other sectoral uses & implementing regionally-based initiatives, eg Regional spatial marine plans • Providing a framework to support the selection of nationally important landscapes, habitats & species, & detailed implementing of OSPAR proposals in due course; and • Providing a regional delivery framework to enable national biodiversity objectives to be expressed at a more meaningful scale.
Marine, coastal & estuarine landscapes 10s – 10,000's km^2	• Mapping the extent & distribution of marine landscape types in all UK waters, forming a 'countryside map' for the seas; • The planning & identification of site-based networks and of maritime landscapes requiring special conservation action; • The protection, conservation & management of landscapes through the application of appropriate measures, including site- and non site-orientated measures.
Habitats & species ca 0.01 – 1000's km^2	• Habitat & species classification systems, & assessments of environmental sensitivity & recoverability; and • Recovery of structure and functioning through the creation of undisturbed areas.

Table 2 Principle elements of an integrated ecosystem-based approach to conservation and utilisation of maritime ecosystems

'Nested' ecosystem elements & comparative scale	Management framework goals	Analysis of current management framework	Gaps in management framework	Development priorities:	
				Governance	Science
Large Marine Ecosystems ca. 200,000 km^2 or larger	Integrated actions arising from international & domestic obligations & agreements, achieved through legislation, regulation & policy instruments & guidance. Actions should address all marine & coastal areas, all elements of biodiversity at all scales & all values (intrinsic, ecological, cultural, scientific, aesthetic) National planning and management framework (?ICZM)	Main elements present but greater cross-sectoral coherence needed, and greater and more equitable action on ecosystem targets & obligations, as well as matching goals for exploitation & use with those for ecosystem recovery & maintenance. By contrast current actions predominantly relate to exploitation and use. Absence of comprehensive approach to mobile species, from identification through to achieving actions – current focus is still on rare, scare & declining species rather than on delivering protection through tools related to the nested elements in this table. No coherent overarching national overview for planning and management. For ICZM stock take and follow up to EU recommendation may help	Lack of clear ministerial responsibility for the sea and lack of effective co-ordination mechanism between UK Government departments and in devolved assemblies. Need an overarching framework to deliver an ecologically-based and cross-sectoral integrated planning and management system for England's (UK's) coasts and seas, which recognises and ensures hierarchical interdependence and that integrates with European-level initiatives To deliver framework, need first to address and make effective underpinning tools, eg sea use planning. Need better coordination of national science and better derivation and use of ecosystem evidence in deciding on policy and legislative needs. Enforcement and reporting	Improved strategic coordination & leadership to adopt and deliver an ecosystem approach to stewardship of coasts & seas (eg through the establishment of a National Ministerial Board supported by a cross-sectoral national s Advisory Committee – pending recommendations from the Irish Sea Trial). Improved understanding & acceptance of the need for long-term social, economic & environmental targets and trends for the protection of maritime ecosystem goods & services. Develop national planning and management (ICZM?) framework based on improved tools such as sea use planning. Enforcement and reporting competencies and capabilities	Development of a process to deliver greater access to marine information, and the need for improved strategic coordination of the theoretical & applied maritime research communities, within and outside both Government & industry (eg through the development of a National Maritime Science & Technology Plan). Identification and implementation of appropriate national level long-term ecosystem targets (concept of good ecological status) for the maritime environment. Better translation of science into information for policy, risk management & planning.

'Nested' ecosystem elements & comparative scale	Management framework goals	Analysis of current management framework	Gaps in management framework	Development priorities:	
				Governance	Science
Regional seas & coasts ca 6000 – ca 70,000 km^2	Integrated Marine and Coastal Area Management. Achieved through regional management plans linking catchments, coastal and marine ecosystems, set within national framework (including operational expression of national strategic goals) and guided by national instruments such as policy. Underpinned by a common cross-sectoral information base on spatial & functional aspects of ecosystems & their component elements.	Few main elements present: some acceptance of need for regional scale but absence of framework for delivery. Adhoc ICZM initiatives but no coherent national overview. Management of different sectors, and key underpinning tools, also need improving, eg fisheries, eg spatial planning for developments/industrial use The RMNC Irish Sea Trial important but only limited first step. Current work is largely descriptive & needs to embrace functionality more. Trial is sectoral (ie nature conservation) but derived outputs need to underpin a government/industry-led approach to deliver 'marine sustainability' for all sectors & uses.	Need to develop a national process for the delivery of suite of complementary spatially & sectorally integrated regional management plans that are nested into this hierarchical approach. Actions on ICZM communication will contribute towards this process. Need to address and make effective underpinning tools, eg sea use planning, at regional level. Enforcement and reporting	Development of 'Regional Maritime Plans' (making links to Regional Advisory Councils under the Common Fisheries Policy) that are integrated into the national-local hierarchy and implemented and championed by cross-sectoral Steering Committees. Enforcement and reporting competencies and capabilities Development of sustainable tourism strategies.	Improved coordination of the regional maritime research communities, within both Government and industry (eg through the establishment of Regional Maritime Science & Technology Advisory Committees – pending recommendations from the Irish Sea Trial). Identification and implementation of appropriate regional level ecosystem targets for the maritime environment. Applied understanding of functional processes to support better management of human uses, to enable work towards the delivery of ecological coherence, and best manage the wider environment including to the benefit of sites.

'Nested' ecosystem elements & comparative scale	Management framework goals	Analysis of current management framework	Gaps in management framework	Development priorities:	
				Governance	Science
Marine, coastal & estuarine landscapes 10s – 10,000's km^2	Conservation and protection of ecosystem function and processes delivered through a combination of wider management measures and more targeted management delivered through a network of multiple-use marine & coastal protected areas (MCPAs) that is representative of landscape types and based on scientific principles of network design.	Absence of a representative and ecologically relevant MCPA network at the landscape level, underpinned by effective national legal structures and governance Some elements of a network in place but yet to be integrated appropriately to form a coherent network: Natura 2000 (international interest, good legal basis, mainly near-shore, gaps in habitat & species coverage, long-term process); OSPAR MPA (more comprehensive than Natura 2000, could be more 'immediate' but no UK sites agreed & little current legal basis); voluntary-based initiatives in some areas (estuary management plans).	Need an overall plan with full national-local integration, including a strategy and timetable for the implementation of a network of multiple-use MCPAs. Enforcement and reporting	Expansion of governance regimes from Natura 2000 sites to the whole network, including OSPAR and (missing) national elements. National legislation & policy expanded similarly to cover OSPAR and national interests. Understanding of what a network is, acceptance of established global network design principles & governance of such networks Enforcement and reporting mechanisms	Resource inventory: landscape distribution over UK designated area. Understanding of physical processes at landscape level to explain landscape distribution patterns. Understanding of functionality to manage within multiple-use MCPA sites Network design (larval dispersion etc) Sensitivity mapping Landscape/habitat links

'Nested' ecosystem elements & comparative scale	Management framework goals	Analysis of current management framework	Gaps in management framework	Development priorities:	
				Governance	Science
Habitats & species ca 0.01 – 100's km^2 Conservation and protection of ecosystem structure, delivered through a network of Highly Protected MCPAs that is both representative and based on scientific principles of MPA network design	Some limited explorative discussions but no overall ecologically coherent approach, legislative or policy frameworks, resulting in virtual absence as a practical tool for biodiversity protection & recovery in England (& UK/Europe). Good international body of evidence derived from widespread practical application outside Europe. One site for marine habitats & species in England (Lundy, 2003, 3.3 km^2). Science-base developing through JNCC's NBN gateway (including 'Mermaid'), and the Marine Biological Association's MarLIN (sensitivity & recoverability) and MarClim (climate change) initiatives. Lack of functional/applied research links.	Need an overall plan for a Highly Protected Area network with full national-local integration, including a strategy and timetable for implementation. Enforcement and reporting	Governance should sit largely within the landscape-nested element (above) but needs to be developed to explicitly cover the Highly Protected Area regime, whether as sites within multiple use MCPAs or sited outside (in order to help deliver ecological coherence). Exploring and agreeing the relationship to fisheries management is a priority. Enforcement and reporting mechanisms		Relationship to landscapes and the landscape/habitat links needs to be better understood. Gaps in detailed survey information for habitats & species inside sites (gathered through opportunistic or targeted survey & remote sensing work, supported by landscape mapping and understanding of landscape/habitat links). Holistic mapping to provide strategic approach to protection and use.

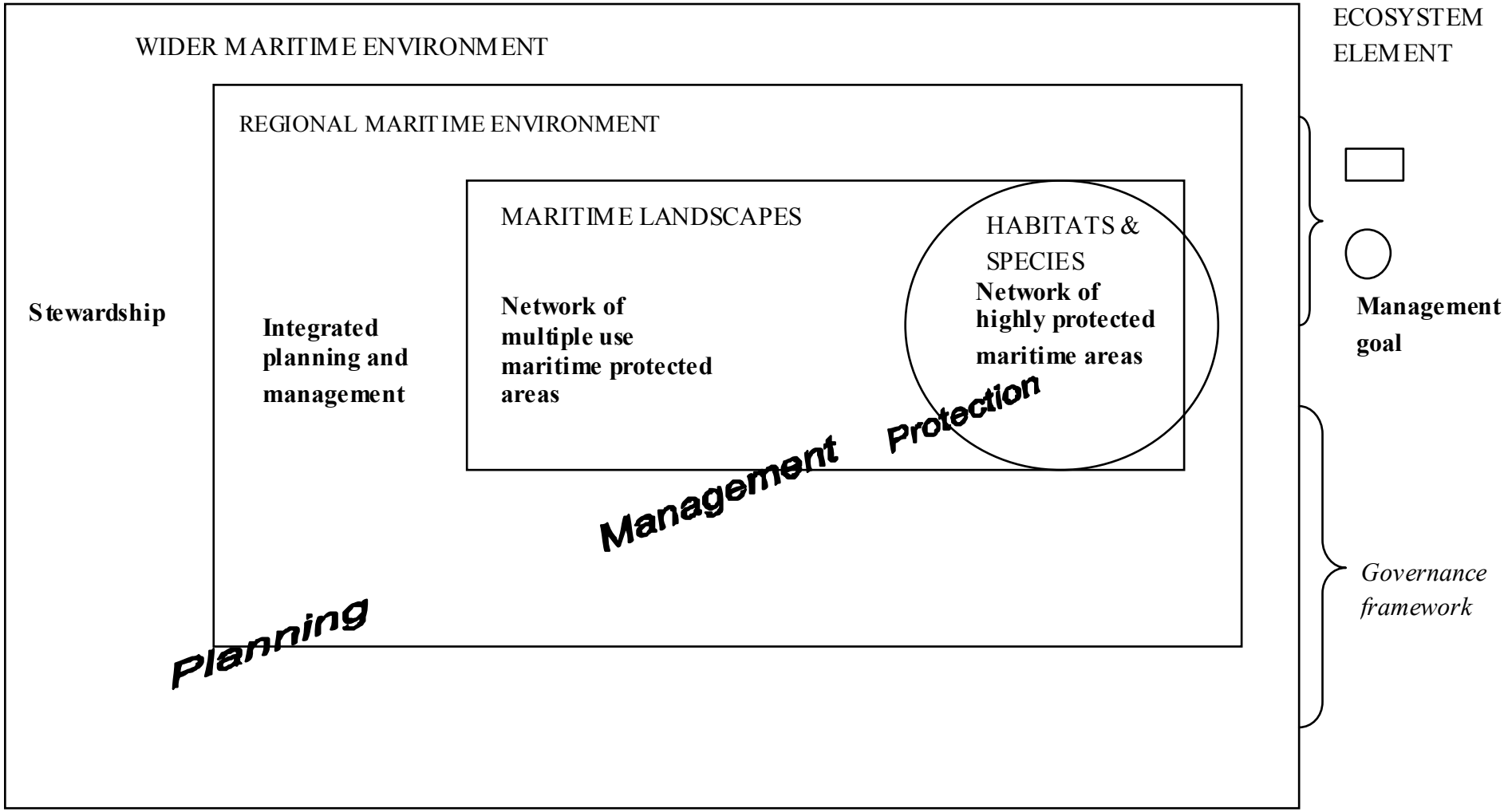

Figure 2 Schematic of key elements of ecosystem hierarchy, goals and governance

Table 3. An illustration of how focussing on the components of marine ecosystems can help develop a view on the minimum ecological indicator set required to report on overall marine ecosystem health. Socio-economic indicators need to be added to complete this picture.

Ecosystem component	Focus	Goal	Example of possible indicators
Food webs			
- Productivity	Plankton	SAHFOS to advise	Chlorophyll a, ratio of plankton characteristic of eutrophic/tending to eutrophic conditions.
	Biomass	Stabilise/reduce frequency of extreme fluctuations?	Spawning stock biomass
- Trophic structure	Trophic structure	A halt in the decline in trophic structure of marine ecosystems and subsequent recovery of structure	Trophic structure of caught fish
Species assemblages	Fish assemblages	Recovery of assemblages	Metric of fish community structure, commercial stocks outside safe biological limits
	Sediment assemblages	Recovery of assemblages	Diversity and age of key infaunal species
	Reef assemblages	Recovery of assemblages	Diversity indices
	Seabird assemblages	?Recovery of assemblages	Breeding success e.g. kittiwakes, changes in distribution of scavenging species and those that feed on small fish e.g. guillemots
Habitats	Quality and extent	Maintenance of quality and extent of irreplaceable habitats	Key habitats
		Maintenance in quality and extent of fragile and/or sensitive habitats, and increase area and recover quality where impacted	Key habitats
		Reduction in levels of contaminants in water, sediment and biota	Nutrients, heavy metals etc
	Diversity	Maintain current diversity of habitats and recover where impacted	Diversity indices
Species	Range	Expand range of slow growing, long-lived and/or low fecundity species	Sharks, skates, rays, cetaceans
	Size	Halt downward trends in populations and increase average size	Bycatch analysis, metric of fish community structure

Ecosystem component	Focus	Goal	Example of possible indicators
	Cohorts	Expand age classes present in populations	Population age structure of key species, metric of fish community structure
	Abundance	Increase abundance of slow growing and/or low fecundity species	Frequency of capture in reference trawls
Maintaining the gene pool	Extinctions	Prevent extinctions at local, regional, national and global levels	Frequency in surveys of key species
	Range reduction	Prevent anthropogenically determined range reductions	Age of range for key species
	Vitellogenin precursor?	Prevention of levels of endocrine disruption that interfere with reproductive behaviour	Key species of fish - ? flounder and cod
	Niche disruption including cross-breeding	Prevention of introduced and/or genetically modified organisms displacing or interbreeding with native flora and fauna	New introductions and spread of those species already established but limited in range

Annex 1 Report previously submitted by English Nature and others to the Defra RMNC Working Group

LAFFOLEY, D.d'A. & BINES, T. 2000. Protection and management of nationally important marine habitats and species. Prepared by English Nature based on the views of a sample for the members of the DETR Working Group on the Review of Marine Nature Conservation. Peterborough: *English Nature Research Reports*, No. 390. 20 pp.

LAFFOLEY, D. D'A. 2000. Historical perspective and selective review of the literature on human impacts on the UK's marine environment. Prepared by English Nature for the DETR Working Group on the Review of Marine Nature Conservation. Peterborough: *English Nature Research Reports*, No. 391. 20 pp.

LAFFOLEY, D. d'A., CONNOR, D.W., TASKER, M.L. & BINES, T. 2000. Nationally important seascapes, habitats and species. A recommended approach to their identification, conservation and protection. Prepared for the DTR Working Group on the Review of Marine Nature Conservation by English Nature and the Joint Nature Conservation Committee. Peterborough: *English Nature Research Reports*, No. 392. 17 pp.

LAFFOLEY, D. d'A., BAXTER, J., BINES, T., BRADLEY, M., CONNOR, D.W., HILL, M., TASKER, M. & VINCENT, M. 2000. An implementation framework for conservation, protection and management of nationally important marine wildlife in the UK. Prepared by the statutory nature conservation agencies, Environment Heritage Services (Northern Ireland) and JNCC for the DETR Working Group on the Review of Marine Nature Conservation. Peterborough: *English Nature Research Reports*, No. 394. 29 pp.

LAFFOLEY, D.d'A, VINCENT, M., CONNOR, D.W., HILL, M., & BREEN, J., 2002. Strategic goals and objectives for marine nature conservation, and associated indicators. Prepared for the Review of Marine Nature Conservation by English Nature and the Joint Nature Conservation Committee. Peterborough: *English Nature Research Report*, No. 482. 23 pp.

Copies of these reports can be obtained from the enquiry team at English Nature in Peterborough.

Annex 2 Relationship of the framework in Table 2 to the ecosystem approach and underlying principles

In relation to the framework set out in Table 2 and the ecosystem principles contained in annex 3, the following linkages against these twelve principles are evident:

- **Principles 1 and 6**: 'the objectives of management of land, water and living resources are a matter of societal choice' and '…there is usually a need to manage the ecosystem in an economic context'. The framework sets out a need to develop a plan for forward-looking, long-term social, economic and ecological targets and trends, putting the ecosystem at the heart of the management/stewardship of man's maritime activities, in parallel with the need to develop the concept of good ecological status for maritime ecosystems.
- Principles 2 and 3: Management should be decentralised to the lowest appropriate level and the ecosystem approach should be undertaken at the appropriate spatial and temporal scales. The framework sets out and broadly characterises different spatial scales, reflecting different levels of functionality. It also sets out the appropriate "management" approach at each spatial scale. In particular, it highlights the need to decentralise planning and management from the national to regional level as much as possible. Further, addressing such inherent temporal ecological variations requires the use of the range of measures identified in the four nested levels.
- **Principles 4**: *'…objectives for ecosystem management should be set for the long-term*. The framework sets out the need for long-term social, economic, and environmental targets involving institutional change and permanent measures to protect and afford recovery for maritime biodiversity.
- **Principle 5**: '*Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems'*. This issue is covered through the adoption of Integrated Marine and Coastal Area Management. Principles 4 and 5 will ensure ecosystem function is maintained over the longer term and that the cumulative impacts of all activities are truly sustainable.
- **Principles 7, 8, 10**: 'Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target…', 'Ecosystems must be managed within the limits of their functioning' and '….seeking the appropriate balance between, and integration of, conservation and use of biological diversity'. The framework tackles this priority through a number of routes: by taking a 'nested approach'; by directing measures at the conservation of seascapes and the protection of ecosystem structure through adoption of comprehensive network design principles; and by identifying priority science needs to understand functionality and ecosystem linkages at a several scales. The development and integration between forward-looking, long-term social, economic, and environmental goals provides a mechanism to manage within ecosystem functioning.
- **Principle 9**: '*management must recognise that change is inevitable*'. The framework addresses this issue through identifying the need for governance to

provide leadership at national and regional levels to enable the review of regional plans, as well as incorporating the learning attained at all scales i.e. adaptive management.

- **Principles 11 and 12**: 'the ecosystem approach should consider all forms of relevant information including scientific and indigenous and local knowledge, innovations and practice' and 'the ecosystem approach should involve all relevant sectors of society and scientific disciplines'.. The framework covers these issues through: requiring that the overall management goal addresses all marine and coastal areas, all scales and all values; the development and integration between forward-looking and long-term social, economic, institutional and environmental targets; and by identifying the need to better link the applied and fundamental research communities through a national science plan.

Annex 3. The 12 principles recommended by the Conference of Parties of the Convention on Biological Diversity in 2000 to guide signatory countries in the practical application of the ecosystem-based approach

1. The objectives of management of land, water and living resources are a matter of societal choice.

2. Management should be decentralised to the lowest appropriate level.

3. The ecosystem approach should be undertaken at the appropriate spatial and temporal scales.

4. Recognising the varying temporal scales and lag-effects that characterise ecosystem process, objectives for ecosystem management should be set for the long-term.

5. Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.

6. Recognising potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context. Any such ecosystem-management programme should: reduce those market distortions that adversely affect biological diversity; align incentives to promote biodiversity conservation and sustainable use; and internalise costs and benefits in the given ecosystem to the extent feasible.

7. Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of the ecosystem approach.

8. Ecosystems must be managed within the limits of their functioning.

9. Management must recognise that change is inevitable.

10. The ecosystem approach should seek the appropriate balance between, and integration of, conservation and use of biological diversity.

11. The ecosystem approach should consider all forms of relevant information including scientific and indigenous and local knowledge, innovations and practices.

12. The ecosystem approach should involve all relevant sectors of society and scientific disciplines.

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Paul Glendell/English Nature 24,888
Bottom left: Using a home-made moth trap.
Peter Wakely/English Nature 17,396
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